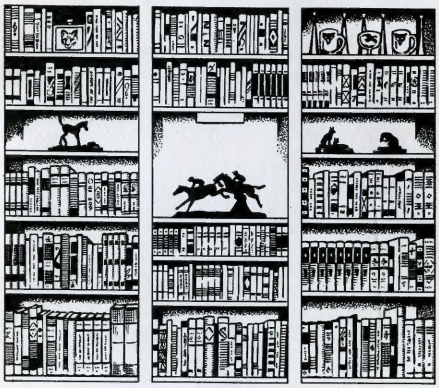
"GRISWOLD GRAY"

F. GRAY GRISWOLD



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JOHN AND MARTHA DANIELS

THE LIFE-HISTORY OF THE CANADIAN SALMON (*Salmo salar*)

MAP SHOWING LOCATION OF THE SALMON RIVERS OF CANADA.

THE LIFE-HISTORY
of the
CANADIAN SALMON
Salmo salar

F. GRAY GRISWOLD

PRIVATELY PRINTED
1929

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To the

HON. JOHN HALL KELLY, K.C.

The Ambassador and Friend

of *Salmo salar*

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FOREWORD

THE powers that be in Canada do not appreciate what a valuable harvest they might have from their salmon fisheries if the approaches to the rivers were managed in such a way that the salmon might be allowed to arrive and multiply in a normal manner.

This is prevented by over-netting.

I have often heard it said that it was not worth while to preserve the salmon, that salmon fishing was simply a sport of the idle rich, and that salmon as a food was a needless luxury.

The combined rod catch of the three chief salmon streams in Eastern Canada, the Ristigouche Club, the Moisie and Grand Cascapedia, during the great year of 1925, was 5,008 salmon. The unreliable reports from the nets in the Provinces of Quebec and New Brunswick the same year totaled

5,078,700 pounds. Estimated at 10 pounds to the fish it totals 507,870 salmon!

Mr. J. Arthur Hutton, the celebrated English authority, says in his book:[1]

" Salmon is not a luxury, but a cheap form of food. For example, compare salmon with cod. There is very little waste in salmon, the skin and bones amount to 23% only. With cod, on the other hand, the wastage is 49%. Then again the flesh of the salmon is very nutritious, one pound containing 700 food calories compared with 166 in one pound of cod, so that when the price of salmon falls below $1 a pound it is cheaper than cod at 25 cents."

The authorities in Canada lease the fishing rights in the rivers for large sums. For example, it costs us $38,000 a year to run our river. By licensing too many nets they allow most of the salmon to be captured before they reach their rivers. Under the circumstances this does not seem quite sportsmanlike.

[1] *Life History of the Salmon,* University Press.

Mr. Hutton says further:

"The only cost of the fish harvest is that of catching them. Nature hatches out the fish, rears and fattens them. No other food harvest is planted, grown, and garnered with so little trouble and expense."

Nature is ready to provide man with a rich fish harvest, but cannot accomplish her purpose when man captures the majority of the salmon before they arrive on the spawning beds.

Salmon are very stupid fish, and their habits are such that they are always at a disadvantage. When they first arrive off the coast they are loath to enter their rivers, and "mill" about off shore, swimming in shoals against the tide. This enables the miles of drift nets to capture them by the thousands.

Then again, as they approach the coast they encounter the standing gill-nets. As they swim back and forth against the tides they become gilled on both sides of these nets.

It is a wonder that any fish eventually

arrive in fresh water. Many that do succeed bear gill-net marks.

If the authorities would reduce the number of days that netting is allowed, and reduce the thousands of fathoms of drift-nets which they now license, both the netters and the anglers would soon enjoy better fishing.

What is good for the fish is good for the fisherman, and what is of benefit to the angler also, in the end, benefits the net fisherman.

The river Wye in England has been completely resuscitated by limiting the netting to three days a week.

Our fish have a doubtful free fairway on Sundays only.

STATISTICS

The importance of the Canadian salmon fisheries is very great, and it behooves the authorities, if they are wise, to make it far greater.

The reports of the nets of New Brunswick

and Quebec from 1911–1928 account for 554,873 cwt. of salmon. At an average of 10 pounds to the fish it totals 5,548,730 salmon in 17 years!

In 1907 there were 4 boats, using 2,400 fathoms of drift nets, in the waters between the Miramichi River and North Point, Prince Edward Island. In 1925 the boats had increased to 52, and the nets to *35,000 fathoms*. It is said there are now (1929) 123 boats along the coast, each *restricted* to *750 fathoms* of nets! Fishing is allowed from May 16 to July 31 — practically during the full run of the salmon.

MIRAMICHI NETS

1925	52	boats	3,534	cwts.	Drift	4,430	cwts.	Set Nets
1928	88	"	2,692	"	"	1,178	"	" "
1929	113	"	4,342	"	to June 30	933	"	" "

The run was light in 1928 and 1929.

In 1925 35,000 fathoms of Drift nets

" 1929 84,950 " " " "

THE SALMON

THE SALMON

ALTHOUGH the salmon that frequent the rivers of Canada are of the same species as those that run into the rivers of Great Britain, their habits differ owing chiefly to weather conditions.

Our rivers freeze in winter, but those of Great Britain do not, so that our fish have but one short season in which to fulfill their chief desire, namely the continuance of their species. In other words, the salmon of Canada enter the rivers at one season only, and have but one spawning time.

In Great Britain they have more than one run of salmon during the year. In the large rivers of the East coast of Scotland there is a Spring run as well as one late in the season. In fact there is no month in the year during which the fish do not ascend these rivers, yet the small streams see no salmon before the month of March.

The English and Scotch salmon are divided into Spring fish, small Summer fish, and large Summer fish, which arrive at different seasons. There is no such distinction in Canada. The different sizes of fish follow one another in close order. In the Cascapedia the large females arrive first, and are closely followed by the large males and the maiden fish.

Nature provides that the henfish arrive early, for with fully developed ova the upstream journey becomes too arduous.

The more we study salmon the more we have to realize the very considerable amount of time which they spend in the sea, yet it has never been discovered where they dwell in salt water.

The salmon of Canada go into the Atlantic Ocean, but the fish of Scotland and England have the North Sea also as a possible habitat. This may partly account for their different habits, for the water temperature differs along the coasts of Great Britain in these two bodies of water.

Mr. Menzies [1] tells of a 25-foot shark that was captured off Peterhead in August, 1911, containing 10 salmon from 10 to 12 pounds each, and it is known that the Dogger Bank fishermen sometimes take salmon in their nets.

The first salmon arrive off the coast of Nova Scotia early in April, and enter the Medway and other rivers, but the St. Lawrence and the Bay of Chaleurs fish do not appear until late in April. They remain in salt water, swimming back and forth against the tides, until the temperature and strength of the river water is agreeable, before they attempt the upstream journey.

The Cascapedia fish wait until the snow water has run out. This season — 1929 — the first salmon was taken in the Carleton nets, near the mouth of the river, on April 23. The first fish taken on a fly in the lower waters was on June 5, and on the Club waters on June 18, when the temperature of the river water was 47°.

[1] *The Salmon,* Blackwood.

It appears as if the river water must be above 45° before the fish run up freely, and they do not enter the tributaries of a river until later, as their waters are colder than those of the main stream.

There are early rivers and late ones. The reason for this is not fully known. Buckland claimed that the seasonal character of a river depended on its length in proportion to the square mileage of its drainage area, but later observers believe it depends greatly on water temperature.

Early in the season the river water is much colder than the sea, but on an average river water is only 4° colder than sea water.

In the Cascapedia the salmon take the fly readily when the water is between 45 and 55°, but do not rise freely if it is much warmer.

THE SALMON

(continued)

THE SALMON

(*continued*)

LITTLE was known concerning the life of the salmon prior to 1904. What had been believed was mere surmise. It was supposed that all the fish that survived in the sea increased in size, and returned year after year to the rivers to spawn.

There was also a difference of opinion concerning the young salmon. In early times the *salmon parr* was given the name *salmo salmulus,* for it was considered to be a small member of the salmon family, but was not recognized as being a young *Salmo salar.*

In 1904 Mr. H. W. Johnston published an article in the "Field," describing his discovery that the life history of the salmon could be told by the examination of the fish's scales, and scale-reading became a science. It is not a difficult science, and a microscope

is not needed, yet much practice is necessary to become proficient.

Select a perfect salmon scale, wash it clean, place it on a piece of glass and examine it with a magnifying glass. You will find that the scale has a center, or core, consisting of fine lines, some close together, others wider apart. This part of the scale represents the fresh-water life of the young salmon, or *parr,* before it goes to sea as a *smolt.*

Each couple of zones of lines represent one year in the river. The close lines the winter feeding, and those that are wider apart the summer forage. Count the zones only — the lines do not always run true.

When a small fish receives scales they are numbered, and as the fish increases in size the scales must also increase in size, for they do not increase in numbers.

The scale grows larger by the formation of ridges around its outer edge. These ridges, or lines, are very close together on the parr scale, for their food is meagre and they grow

slowly; but when they go to sea as smolts, and find a goodly supply of food, the ridges become more pronounced, especially during the summer time when the food is plentiful.

If you examine the scale of a maiden fish you may ascertain how many years it has remained in the sea since it left the river as a smolt, by counting the winter and summer zones, and you may estimate its total age by adding these to its smolt age.

During their stay in the river with little or no food, and after the severe strain of spawning, the salmon lose much weight. Many die from exhaustion. Most of the large male fish perish.

As they decrease in bulk, the scales fray at the edges and become ragged. The survivors return to the sea, as *kelts,* and there recuperate rapidly with good food, and increase both in length and bulk. The scales mend and begin again to acquire fresh rings, but a scar, called a *spawning mark* is left. The number of such scars represents the number of times a salmon has spawned.

Few salmon spawn more than once, but this differs in different rivers. About 2% return to most of the rivers in Scotland, yet it has been found that nearly 50% of the salmon in the small river Add spawn more than once.

In Canada a study of the scales of but two rivers has been made, namely those of the Moisie and of the Grand Cascapedia. In both these streams but 15% of the scales examined showed returning fish.

Very few salmon spawn more than twice, and the examination of many thousands of scales has produced but 8 fish that had returned for the fourth time.

It was supposed that the limit in the age of a river salmon was 8 years, but a fish has been found that was over 13 years of age.

The reading of fish scales is not confined to the salmon, for even the eel has tiny scales underneath its skin which tell its age.

By marking smolts and kelts it has been discovered that 99% of the fish that return enter their native rivers.

Mr. Hutton writes me:

"I believe that salmon try to get back to the very spot where they were born. We have a record from Loch Lomond of a sea-trout being caught (for hatchery purposes) in the same identical spot in three successive spawning seasons, having gone down to the sea during the intervening periods."

A wise provision of nature is that the salmon that enter a river in any one year, for the purpose of spawning, are the product of at least 8 years hatching. Nature in this manner prevents the destruction of the breed by the failure of any one year's harvest.

The netting rights of the Moisie River were held some years ago by an Irishman who was displeased with the size of the fish. He imported spawn from a large-fish river in Ireland, and planted it in the Moisie. We know from rod scores that still exist that in the 1850's the average weight of Moisie salmon was 15 pounds. The average weight of fish taken in 1927 was 19 pounds, showing that it is possible to improve a river's fish.

It is said that many years ago Frank Buckland introduced 700 young salmon from the Rhine into the waters of the river Wye. Within five fish generations the salmon in the river became larger, and ran earlier; yet, as the Rhine salmon do not take the fly, the introduction of these alien fish may be the reason why the salmon in the Wye prefer "bait" to flies at the present time.

CLASSIFICATION

CLASSIFICATION

ALEVIN	The tiny creature when first hatched.
FRY	The little fish five weeks later, after having absorbed its yolk-sack.
PARR	A little later, having acquired scales and finger-marks.
SMOLT	The migratory fish having adopted a silver livery.
GRILSE	The precocious fish that return after being one year in the sea.
MAIDEN FISH	Salmon on their first return to the river.
SPAWNED FISH	Those that have previously visited the river and have returned again.
KELT	Salmon in poor condition owing to fatigue of spawning. " Spent " fish.
MENDED KELT	In Canada, a kelt that has

	wintered in the river and has acquired a bright livery.
BAGGOT OR RAWNER	A henfish full of unshed ova.
DROPPER	A salmon that temporarily deserts fresh water and again enters the sea.
BLACKFISH	A diseased salmon. Often caused by blindness.
UNCLEAN	A fish nearly ready to spawn or having just spawned.

SPAWNING

Seventy-five per cent. of the salmon that arrive in our river fight their way upstream to the spawning beds, or redds, above Lazy Bogan. Here, and in the upper branches of the main stream, they spawn in late October and early November. Those that remain in the lower pools, and the late arrivals, spawn all along the river.

Prior to the actual spawning period the salmon gradually acquire a camouflage of black, red, and copper color, the scales sink

into the skin, which is covered with a thick mucus, and both the upper and lower jaws of the male fish become greatly prolonged.

In the course of spawning the female salmon lose from one-quarter to one-third of their weight, and the males become weak and emaciated.

The spawning takes place in strong water two or three feet deep. The henfish selects a place with fairly large gravel and stones, for sand or fine gravel would smother the eggs. The henfish do all the work, as the cockfish pass their time fighting.

The female, having selected her nest, comes to the surface, arches her body and on her side wriggles upstream as she exudes her eggs, throwing up gravel and stones as large as goose-eggs. She is enabled to do this owing to the specific gravity of stones under water, and with the assistance of the river current.

This is repeated every few minutes. The male follows and fertilizes the eggs. These actions continue for six days or longer, as all the eggs do not ripen at the same moment.

Ultimately the bed is three or four yards long, and the eggs are covered with stones. The female then leaves the redd, and the male watches it for a time unless enticed away by a fresh female.

The loss of eggs in the hatcheries has been reduced to 1%, but in the river it is far greater, for they are devoured by trout, eels, and other fish. Floods may destroy them, or droughts may leave the redds high and dry, and the ova exposed to the frost. For this reason nature provides that a henfish may exude nearly as many thousands of eggs as she has pounds of weight.

Each egg resembles a small, translucent elastic ball, and, if fertile, sinks. The unfertile eggs float downstream and are devoured by the trout. If the eggs are not fertilized by the male they become water-logged and opaque.

The eggs lodge in the crevices between the stones until they hatch. A constant current of water is necessary to supply the oxygen which is needed to complete the hatching.

This period depends on the temperature of the river water. If the water is about 48° the eggs hatch in 100 days. If the water is colder, the process takes longer. The average of possible hatching is believed to be about 15 weeks.

Low water conditions are the best for spawning, for then the eggs must be deposited in the river bottom and out of harm's way.

Salmon eggs placed in brackish water, two parts of sea water to one of fresh, will not hatch.

ALEVINS

Probably 50% of the eggs are not fertilized. Those that are hatch in about three months, and each egg produces an *alevin* less than an inch long. These helpless, tiny creatures have yolk-sacks attached to them. They subsist on the contents of their sacks for from six to eight weeks, and then become *fry*.

FRY

The finger-marks now begin to appear, and the fish acquire scales. The length of time that passes before the fry begin to feed on insects depends on water temperature. Nature provides that no food is required until it is plentiful. When the following winter comes the fry become dark in color, and hibernate among the stones.

PARR

The following spring they have the true coloring of the parr and are often mistaken for trout. They are, however, more graceful than trout of the same size, have fewer red spots, their adipose fin is not tinged with orange and red as with the trout, and the latter has a larger mouth.

The further north the river the slower the parr develops, for it is a question of short summers, cold water, and poor food.

The greater part of the parr in Great Britain go to the sea as *smolts* when two

years old, but it has been found that the parr in some of the rivers of Norway and Canada remain three or more years in fresh water before thay are fit for the sea.

From what we know of the Grand Cascapedia 58% of the parr become smolts when three years old, 34% at the age of four, and a few remain in fresh water for five years. This is supposed to be caused by short summers and lack of food, yet the Moisie River, which is further north, sends 56% of her smolts to sea when two years of age.

The parr have many enemies. Small boys, kingfishers, merganzers, and other birds take heavy toll, but their worst enemy in Canada is the sea-trout, or *charr*. These fish not only compete with the parr for food, but devour the little fish in great numbers.

SMOLTS

When a parr acquires a migratory impulse it gradually assumes a silver coat and a blue back. These cover its spots and finger-

marks. The change is, however, only surface deep. If the scales are removed the parr markings are still to be found on the skin underneath.

A parr does not become a smolt unless physically fit to run the dangers of the deep. This depends on the food it has been able to find, and on its consequent growth.

It may happen at the end of one year or at any following spring up to five years. The further north the river, the colder the water, the less the forage and feeding time, and the greater is the smolt age.

Although the two-year-olds predominate in most rivers, three-year-olds and four-year-olds are not uncommon.

The river Wye in England is 150 miles long. Six per cent of its parr migrate when twelve months old, 89% reach the smolt age when two years old, and only 5% remain in the river for three years. This means that the food in the Wye is plentiful.

The Moisie River in Canada shows that

56% are two years old and 39% three years of age.

The Grand Cascapedia scales that were examined lead one to believe that but 6% leave the river as two-year-old smolts. The three-year-olds form 58.8%, and the four-year-olds 34.1% of the total.

This means that the Cascapedia is a rocky bottomed, rapidly running stream, in which little vegetation can possibly grow, and that the supply of food is poor. The parr remain a long time in the river at the mercy of their many enemies. It also means that everything should be done to protect them. The birds of prey should be destroyed, and the sea trout eliminated.

The length of the smolts differs in different rivers.

The older the smolt is when it goes to sea the sooner it returns. The well-fed, well-grown smolts are those that go to sea first, and being exceedingly healthy subjects, they are the ones that remain in the sea, enjoying the good food with no early thoughts of re-

production. In the Cascapedia these fish return as maiden, six-year-old salmon, and weigh from 20 to 30 pounds.

The parr that have had a harder struggle for existence remain in the river for more than three years. They return sooner, and are smaller in size.

We ought to do everything possible to protect the early maturing type of fish if we desire to preserve the average weight of our salmon.

In Scotland it is said that the smolts assemble at the top of the tide, and depart in detachments during May and June. They may be present in thousands one day, and the following day none are to be seen. Where they go in the sea is a mystery.

I have never met anyone who could advise me as to the habits of the smolts in Canadian rivers. Our head guardian has never seen a smolt in the Grand Cascapedia. Their migration must take place in the early spring under the ice.

The mortality of smolts in the sea must be

very great. Mr. Calderwood marked 6,500 smolts in the Tay in 1905, and but 110 were recaptured as adult fish.

GRILSE

It was formerly supposed that the smolts went down to the sea in the spring and returned as grilse in the summer and autumn of the same year, but scale reading has corrected this belief.

A grilse is a precocious, adolescent fish that returns to its river after a little more than twelve months feeding in the sea.

The age of a grilse depends on its smolt age added to its one year in the sea.

Grilse weigh in Scotland from 5 to 13 pounds, but in Canada are smaller. This depends on the river and the food they have been lucky to find in the sea, and also probably on their parentage. In late years the run of grilse in Scotland has greatly decreased, and the reason for this is not known.

To recognize a grilse surely, its scales must be examined, but there are certain out-

ward signs which afford clues to their identity.

The tail is forked, the "wrist" of the tail is slender, and the scales shed readily. Their fins are also somewhat larger for the size of the fish, which I believe is why they are more active than salmon of the same weight.

Grilse are fast swimmers. A grilse that was marked at the entrance of Inverness Firth travelled to the estuary of the Forth, 250 miles, in 7 days, or at a rate of 35 miles a day. They are also wonderfully clever in avoiding the nets.

In Canada only some rivers contain grilse. They are plentiful in the Godbout, and 10% of the fish taken on the rod in the Restigouche are usually grilse, but none are ever found in the Moisie or the Grand Cascapedia. The reason for this is not known, but it probably accounts for so many large salmon in those rivers, for their average weight is 19 and 23 pounds.

Of all the grilse marked in the sea none have ever been recaptured as maiden fish.

There is a greater proportion of males than females among grilse. This proportion differs in different rivers.

All grilse, excepting perhaps the "droppers," are supposed to spawn.

MAIDEN FISH

A maiden fish is recognized by its great beauty — silver brightness — and because it seldom has more than one or two black spots on its gill covers, or below its lateral line.

If you examine the gills of a fresh-run maiden fish, you will find them quite sound and clean, and blood red in color. Maiden fish are far superior as food to fish that are running in for the second or third time to spawn, the flesh of which is pale in color and lacking both in fat and flavor.

The age of maiden fish depends on the number of years they have remained in the sea added to their smolt age. They may be from four to eight years old in Canadian rivers, and vary according to the quality and quantity of food they have been able to

obtain. Occasionally one finds a large fish that has been in the sea for five years without spawning.

The average weight differs in different rivers and in different years. Small rivers usually have small fish, and large rivers big ones.

Each river has its own type of salmon. They are " geared " to their own individual river, which means that after long years of natural selection and the survival of the fittest, a type of fish has developed which is best able to surmount the difficulties of its native stream.

More than one type of fish may be found in a river, for those tributaries which harbor salmon also develop their own individual type.

The Ristigouche fish differ in shape and in average weight from the salmon of its tributary, the Matapedia.

The salmon harvest depends mainly on maiden fish, so that the annual run is most important.

PREVIOUSLY SPAWNED FISH

The salmon might be described as a rapidly growing fish which reaches maturity at five or six, goes once to its stream to spawn, and then dies, yet an uncertain number survive and return again.

These fish on their second or further return can be distinguished by their looks. They are not as silver bright as maiden fish, and their scales appear to be more prominent. They have tattered, dark-reddish-brown gills, containing a few fresh-water gill-maggots, and also have numerous irregular black spots on their gill covers and along their sides. The male fish have pronounced hooked jaws.

Their flesh has not the full-bodied red color of the maiden fish, and they are poor table food.

The returning salmon are mostly henfish, for the majority of the large males perish, after spawning the first time.

The numbers that return differ according

to season. We have very little data on these subjects in Canada. Of the scales that were examined by experts, 16.7% of the Moisie were returning fish. 182 Grand Cascapedia scales showed 48 second spawners and 14 third. In Scotland 93 out of every 100 salmon are maiden fish.

Few salmon return twice, very few three times, and only 8 have been found among the collections of thousands of scales from the rivers of the world showing four spawning marks.

The oldest fish ever found was a little over 13 years of age.

KELTS

After spawning in the rivers of Eastern Canada, the salmon become emaciated and unpleasant looking objects. Those that survive drift later slowly down to the sea, tail first, and there recuperate and regain their brilliant silver livery.

After spawning, the females lose from one-quarter to one-third of their weight and

remain for a time in the deep pools before drifting down stream.

The males remain for an indefinite period on the redds. They are much more exhausted after spawning than the females, and their death rate is very high.

Some kelts make for the sea with little delay, while others in some rivers remain throughout the winter and go to sea the following spring as *mended kelts.*

MENDED KELTS

In Canada a mended kelt is a kelt that has wintered in the river and has partly recovered its well-being. As a rule, these mended kelts have regained a bright coat, but this sheen is one of tin rather than of silver.

It is often difficult to distinguish them from fresh-run fish. They have fresh-water gill-maggots, and although they may appear to be plump it is the result of absorption of water and not of food. The scales from a well-mended kelt show no sign of any new growth.

There are few mended kelts in the Ristigouche and the Moisie, but they are numerous each season in the Grand Cascapedia. They disappear about June 25.

Of the many thousands of kelts marked in Scotland only about 4½% have been found when again clean. It is estimated that 90% must perish in the sea. No Grand Cascapedia marked kelt has ever been recaptured.

PARASITES

Fresh run salmon bear sea lice. These pests do not breed or live in fresh water. They remain attached to the fish for about a week, and then perish.

When in the river, salmon are attacked by fresh-water gill-maggots. When the fish goes back to sea as a kelt, some of these, being well nourished, survive, but they do not breed in salt water. The gills of returning spawned fish plainly show the havoc created by these parasites.

WEIGHT

The heaviest salmon ever taken in Canada was the Grand Cascapedia fish of 54 pounds landed by Mr. R. C. Dun on June 20, 1886. Since then there have been only three fish taken over 50 pounds in weight. Since 1910 I know of 58 salmon over 40 pounds on the Club waters, and some 950 over 30 pounds each.

The average weight of the Moisie fish is about 19 pounds, and of the Ristigouche, 18 pounds, and its record fish, 48 pounds (1925).

It is rare to find a henfish more than 30 pounds in weight, for they seldom remain more than three years in the sea. Those over that weight are usually "spawned fish."

The very heavy male fish have as a rule remained in the sea for four or five years. The greater part of the Cascapedia maiden fish are six years old, 3–3, one year older than those of the Moisie. Of the Ristigouche we know but little.

CONSERVATION

CONSERVATION

MANKIND is by nature wasteful, and the citizens of North America are by habit the most improvident people of the world. The salmon, once so numerous in the rivers of the United States, have all long since been destroyed by sawmills and river dams. A few years of this treatment destroyed the spawning beds, and banished all the salmon.

The day is fast approaching when the salmon of Eastern Canada will be in great danger. The wasteful destruction of the timber, the demand for waterpower, the damming of the rapid streams for the purpose of producing electricity, the increase in the population and consequent pollution, will all tend to destroy the fish.

The provinces of Quebec and New Brunswick are becoming rich through prohibition and the traffic in liquor, and will soon not

need the large sums now received from the rod fishermen, and the citizens of Canada are demanding the right of free fishing in their native rivers.

When that day arrives the salmon will be in great jeopardy. The conditions in Eastern Canada will follow those in Nova Scotia of the present day. The rivers will still flow but salmon will cease to run.

The lessees of the fishing at the present day do their utmost to preserve the salmon. They employ guardians at great expense to watch the rivers and the spawning beds, and many limit their daily and yearly catch. In this manner they do what they possibly can to preserve the parent stock. The lessees also expend large sums in leasing and doing away with those nets in and near the estuaries of their respective rivers that interfere with the approach of the salmon.

The government is not so kind to the salmon. It licenses hundreds of miles of drift nets, and of standing nets, in the sea, which

prevent a sufficient number of fish from reaching the rivers and the spawning beds in order to plant the seed that is absolutely necessary for the continuance of the species.

SALMON (*Salmo salar*) OF THE RIVER MOISIE (Eastern Canada)

BY

W. J. M. MENZIES

SALMON OF THE RIVER MOISIE

INCLUDED in the area of distribution of *Salmo salar* are the western coasts of Europe as far south as the Franco-Spanish border as well as the British Isles and Iceland, and, in addition, the eastern coast of Canada and the United States down to the State of Maine. A very large number of investigations have been made in Great Britain and various European countries, both by marking the fish in order to trace their subsequent growth and movements, and by reading their age and history from the scales. Length calculations from scale measurements have also been made in Scotland, Norway, and Sweden.

Certain marking experiments have been made with *Salmo salar* as a subject both in Canada and the United States, but, so far as I am aware, no effort has been made to deal with their scales, or if so, no results of such investigations have been published.

I therefore approached with some care a small collection of scales of salmon from the river Moisie which flows into the north side of the Gulf of St. Lawrence. Unfortunately the collection could not by any means be called representative, since the sample I have to deal with consists of particulars of only 120 fish caught in 1922 and 257 taken in 1923, while other details of the catch which were supplied to me showed that some seven or eight thousand fish may be caught by nets and rods in the course of a short season of about two months.

The period of collection also of these small samples did not extend throughout the season, but was confined to about a month. One was therefore at a grave disadvantage in the examination of scales, not only from a strange river but also from another country. As a preliminary measure it was only possible to use accustomed methods, but after trial the formation of the ridges and zones of growth were seen to resemble exactly that of the scales of salmon of this country, and

no special difficulties arose in reading the apparent age.

In such rivers as the Moisie, subject to extreme climatic conditions and liable to prolonged and severe cold during the winter months, one does not know in what manner kelts may behave after spawning. I approached the subject of the spawning mark on the scales with the possibility in my mind of a rapid migration from the river by the kelts immediately after the completion of the redds. I was prepared to find a somewhat less definite scar than is usual on the scales of previously spawned fish caught in this country. Fortunately, among the collection sent were the scales of three kelts and a " baggot " (*i.e.* an unspawned female), all caught in late spring or early summer, and these seemed to suggest that some kelts at least spend the winter in the river.

Acting on the assumption that a spawning mark is shown by all fish which have spawned and have again returned to the river as clean fish, I find that of the total of 377 salmon, 63,

or 16.7 per cent., fall into this category. This proportion is very much higher than we are accustomed to find in the rivers of the east coast of Scotland, where it is very unusual for more than 5 per cent. of the stock to be on other than their first return to fresh water.

Of these 63 Moisie salmon, 35, or 9.3 per cent. of the total sample, had spawned once; 11, or 2.9 per cent., had spawned twice; 16, or 4.2 per cent., had spawned three times; 1, or .3 per cent., had spawned four times.

The numbers of salmon which survive to return to the Moisie for a third and fourth time are noteworthy, and more especially is this so in the case of the single fish which had spawned four times, and was on its fifth journey to the river when netted and killed. Of all the scales examined in Scotland, we have records of only three fish which had helped so materially in the reproduction of their species. Two were clean fish, one of 19 lb. from the Conon, and another of 29½ lb. from Loch Maree; the third was a kelt of 12 lb.

RECORD MOISIE SALMON
On fifth journey to spawn
14 years old

caught in the Add in Argyllshire, which, since it was again in the kelt stage, had spawned on five occasions. The Moisie fish weighed 38½ lb., and, like the Scottish fish was a female. Its scales show two years of river life, followed by apparently three years in the sea and then a full year's feeding between each spawning period — that is, it adopted the long-absence habit and spawned biennially, descending as a kelt in the spring of one year, and remaining in the sea until the spring or early summer the following year. Its total age was consequently thirteen years.

As absorption of scale material during the freshwater fast may remove evidence of a complete winter's growth, the age of any of these spawned fish at the time of their first ascent of the river cannot be estimated with absolute certainty, but, as far as can be judged, 58 of the 63 fish spawned for the first time after spending three winters continuously in the sea.

The average age at migration of the Moisie smolts is slightly higher than is usual in the rivers of the north-east of Scotland, but is lower than is found in Norway. In Scotland the majority of smolts are two years of age, but in certain districts as many as 25 per cent. of the total may be three years old. In Norway, the proportion of three-year-old smolts may be as high as 75 per cent. In the Moisie, the percentages of two- and three-year-old migrants were 56 and 39 respectively; the remainder, consisting of those four years old, formed 5 per cent. of the whole, while one fish had spent five years as a parr in the river.

Summary

The analysis is based on a rather small collection of scales and measurements which may possibly be not quite representative of the salmon (*Salmo salar*) of the river Moisie (East Canada).

The portions of the scales representing both river- and sea-life are easily read, and

closely resemble the scales of European salmon in formation and growth, but it is not possible to decide, from the material available, if the periods of slow and rapid growth correspond with the winter and summer seasons respectively.

The majority of Moisie salmon return to the river after spending three winters in the sea; some may do so after an absence of 2+ winters, but those which spend 2, 3+, and four winters away from the river are rare, and apparently grilse (1+ winters group) are entirely absent.

Erosion of the scales during the period of abstinence prior to spawning takes place normally, and a spawning mark is subsequently formed on the scales in the usual manner. The number of fish on their second or subsequent return to the river (16.7 per cent.) is high, and the number which have spawned more than once (11 twice, 16 three times, 1 four times) is relatively considerable.

The average age of the Moisie smolts is

intermediate between that of the smolts of N.E. Scotland and of Norway; 56 per cent. were two years, and 39 per cent. three years, old when they first entered salt water. The balance were four years of age, with the exception of one, which had spent five years in the river.

The average sizes of the 2+ winters group, 9.15 lb. and 29.4 inches, are considerably less than the averages of fish of the same history in Scotland, but the result may be affected by the period of the season at which the samples were taken. In the older group of 3-winters fish the averages, 20.7 lb. 37.3 inches, correspond closely with the Scottish figures. These latter fish are fat and well nourished, as their coefficient of condition, 1.23, shows; they compare favorably with the most finely shaped Scottish fish. The younger group, however, besides having a small average size, have for their length a rather low coefficient of condition — 1.

The sex of each fish was given with the other details, but presumably was judged

from external examination only. The proportion of males seems unduly high, and the erosion of the scales also in many cases does not suggest that the sex has been accurately determined.

SALMON OF THE GRAND CASCAPEDIA RIVER

BY

W. L. CALDERWOOD, I. S. O.

PROCEEDINGS
OF THE
ROYAL SOCIETY OF EDINBURGH
SESSION 1926–1927

SALMON OF THE GRAND CASCAPEDIA RIVER

82 Newbattle Terrace
Edinburgh, 19th December 1926

DEAR MR. GRAY GRISWOLD:

I received the completed record of the Grand Cascapedia scales yesterday, and am now able to give you an account of them.

The leading group is the 3 winters in the sea. There are 94 of them, or 56.3% of the total. The only other group of any size is the 1 spawning mark lot. There were 47 of them, and of that number 33 were 3 winter smolts.

With regard to the 3 winters in the sea group, it has also to be said that a most noticeable feature is the age before the first descent to the sea. 52 of the 94 were 3 year old smolts, and more remarkable still, 32 were 4 year old smolts. There is no 1 year smolt. We have never struck such a high per-

centage in smolt age in any of our British scales. Here is the tale of the 167 samples in brief:

Percentage of Smolt Ages

Age Groups	*Years in River*				
	2	3	4	5	
2 + winters	9.1	54.5	36.4	—	
3 winters	8.5	55.3	34.1	2.1	
3 + winters	—	100.	—	—	
4 winters	—	100.	—	—	
Spawned	1.6	66.6	31.8	—	
Total	6	59.9	32.9	1.2	100

The feeding for smolts in the river must be rather exceptionally poor. If the majority of the fish spawn high up it is a hard country for their offspring. In Norway there are 5 year old smolts in the Finmarken province, which is within the Arctic circle.

With regard to fish which have previously spawned, none had spawned more than twice before the third ascent on which they were killed, *i.e.* they were potential 3 S M fish. There were 13 of these, and for fish which

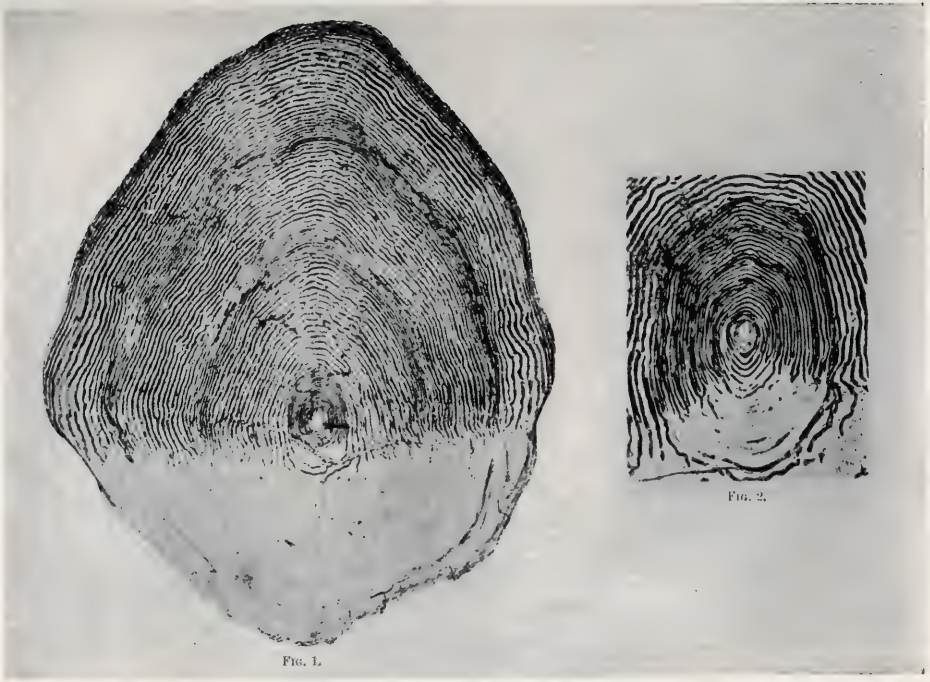

Fig. 1.

Fig. 2.

GRAND CASCAPEDIA SALMON SCALES

have been out of the sea reproducing their species, the weights are wonderfully good. They range from 29 to 41 lbs; and the average is 33½. Both the 29 and the 41 were 4 year smolts; 7 were 3 year smolts.

Now with regard to your heavy fish, only one is above 41, *viz.*, a 42½ lb. fish. It had been a 3 year smolt and had spent 4 continuous years in the sea. After that fish the heaviest lot are contained in the 2 S M group and are the 3 year smolt fish of that group. The weights are: 33, 39, 31, 31, 32, 32, 32. Five of the 7 were females, and one was a doubtful male.

A small fish of 6½ lbs. was marked as a grilse, but the scale reading showed it to be a small summer salmon, a 3 year smolt that had been 2 years and a bit in the sea.

One scale was regarded as that of a kelt, weight not given, length 41 ins., female.

The weights of your most numerous group, the fish which have spent 3 consecutive years in the sea, vary a great deal — from 13 lbs. to 32 lbs.

Of this crowd, those that were 3 year smolts average 23.1, which is just your river average, I think; those that were 4 year smolts average 24.3.

With regard to the youngest group — the 2 + winters — the average weight is 11.7, the average length 30.6 (2 of this group weighed 14 lbs. but a 6 and an 8 brings down the average).

That, I think, pretty well completes a résumé of the data collected except for calculated lengths at each year, and the condition factor, I need not perhaps trouble you with these, but with your permission I should like to put a note about the data in the Royal Society Edinburgh Proceedings here, and if this is done I will of course send you the paper.

With all good wishes for the festive season,

Yours sincerely,

W. L. CALDERWOOD

THE CANADIAN SALMON

THE CANADIAN SALMON

SALMO salar, at one time so numerous in the rivers of our East Coast, are now found only in the waters of the Dominion of Canada.

The rivers to which the salmon now return are not numerous. Many fish are taken yearly, both by rod and net, yet the salmon as a food fish has become a luxury.

There has been very little scientific study made of these valuable and most interesting fish, and nothing has been done to increase their number. There have been a few hatcheries installed at times on different rivers, but they have as a rule been unsuccessful.

I find that the anglers who control the rivers are most conservative sportsmen who diligently read what generations of Englishmen have written on the subject of salmon fishing and follow their advice implicitly.

They do not however follow their British cousins by studying the fish and by introducing methods to improve the rivers, nor do they try to rehabilitate those rivers that were at one time good salmon streams.

There were no salmon taken on the river Esk in England prior to 1872, but spawn had been introduced from the Tees for several seasons. The fishing improved year by year, and in 1924, 958 salmon were caught on the rod that averaged 13.43 pounds.

Twenty-five years ago there were practically no salmon left in the Wye. The stock had become depleted by over-netting. Messrs. Hotchkis and Hutton have by wise measures made the Wye into probably the greatest salmon river in the world. In 1927 the rods took over 6,000 salmon that averaged 19.1 pounds, including 31 fish of over 40 pounds each.

It is a strange fact that the rivers of Great Britain contain yearly *five times more salmon* than enter the streams of Canada.

Our rivers are mostly in the wilds and free

from poaching, while their streams often run through towns and villages in thickly populated districts, and have been fished for hundreds of years.

Their abundance in fish means three things: Nature in the first place, then wise laws, and a strict observance of the same.

The Grand Cascapedia had a great season in 1924. About 17 rods took 1,369 salmon weighing 30,591 pounds. In late October the head guardian counted the fish and estimated there were 4,450 salmon in the river and 500 in Loon Lake. If we double the total number to account for the fish taken in the local nets, and those overlooked by the guardian, it would make the total run for the river, in a very good year, but 13,000 fish.

In 1927, a good year, the rod score on the river Wye was:

6,145 salmon weighing 117,291½ pounds and the nets took:

4,662 salmon weighing 62,824½ pounds — a total of 10,807 fish weighing 180,126

pounds, a score that no river in Canada can begin to equal.

There were 4,464 salmon taken on the Ristigouche on the rod in 1927, 989 of which were killed on the tributaries.

Mr. A. H. E. Wood of Glassel writes that on the small Aberdeenshire Dee,[1] in a good year, from 10,000 to 15,000 fish are taken on the rod and even a greater number in the nets.

The Moisie rod record of 2,060 salmon in 1926 is small in comparison.

The scales of the Moisie and of the Cascapedia salmon have been studied and it has been ascertained that about 60% of the parr of the former river go to sea as smolts when two years old, but in the Grand Cascapedia 60% are three years old, and 35% four years old before they leave the river for the sea.

The longer the parr remain in fresh water, the greater is the number that are destroyed by their river enemies. The kingfishers, sheldrakes, loons, ospreys, and eagles all take toll

[1] There are no salmon hatcheries on these rivers.

of the little fish, but I believe their most destructive enemy is the trout.

British rivers also hold sea trout but they are not our fish, the *charr,* an expert cannibal. Sea trout abound in midsummer in the rivers of Canada. One afternoon last summer two rods took 40 trout on the Cascapedia that weighed from one half to five and one half pounds each.

The trout must displace the salmon parr as the amount of food is limited. A river can only support a definite number of *salmonidæ,* this number being determined by the amount of food available. When the food runs short the *charr* devour the small salmon.

It is not uncommon when salmon fishing to take a five pound trout and find a parr in its stomach.

When the salmon are on the redds shoals of trout lie in wait to devour the salmon eggs.

As we do not know where the salmon winter in the sea it is difficult to say what enemies they have there. It is however well

known that they have two enemies along our coast which are much more destructive than those in the eastern Atlantic, namely the brackish water, or white porpoise, with the local name of " white whale," and the seal.

The St. Lawrence River streams suffer from the white porpoises, especially in late years, as the natives have ceased to hunt them.

In Great Britain most of the rivers flow directly into the sea, so that it is possible for the authorities to control the nets. In the Wye netting is allowed but three days a week.

Most of our salmon rivers in Canada flow into the St. Lawrence River, or into the Bay of Chaleurs, so that the fish have a very long coastal journey on their way to fresh water.

There are gill-nets all along these routes, and the fishermen are allowed to net the salmon every day in the week excepting Sunday. It is said this law is complied with until the Inspector's launch has passed.

They now demand the privilege of fishing on Sundays also.

The weight of salmon captured in the nets is supposed to be reported to the Royal Fisheries Commission, but the honesty of these reports is questioned.

THE ROYAL COMMISSION REPORTS IN CWTS.

	NEW BRUNSWICK	PROVINCE OF QUEBEC
1911	13,017	8,410
1912	13,877	9,091
1913	17,985	12,761
1914	17,056	11,699
1915	17,867	11,795
1916	17,791	15,302
1917	15,983	13,532
1918	17,452	11,139
1919	9,668	5,807
1920	11,477	4,927
1921	20,383	7,805
1922	16,859	12,206
1923	20,682	14,765
1924	33,563	15,080
1925	30,073	20,714
1926	25,131	15,536
1927	22,464	14,840
1928	12,166	6,905

A catch of 20,000 cwt. would mean 100,000 salmon of 20 pounds each.

Total 2,754,995 salmon of 20 pounds each in eighteen years.

This means that the netting is excessive and that it is a wonder that sufficient salmon can possibly run the gauntlet for the purpose of reproduction.

It is hardly possible that the redds are damaged by the outgoing ice, but quite probable that the newly hatched young salmon may suffer greatly during the Spring freshet.

Most rivers do not freeze solid, for otherwise the numerous kelt would not be on hand in the spring. My guides tell me they have seen blocks of ice floating downstream containing frozen kelt.

Owing to a Spring and an Autumn run of salmon in Scotland the angler is allowed to fish as many months as we do weeks in Canada, yet owing to high and low water conditions he does not actually enjoy very many more days of sport than we do. Mr. Wood

writes that his limit on the Dee is four months subject to water conditions.

As they enjoy a longer season it is no wonder that they take more fish than we do, but that is not the question.

The question is: Why is the number of salmon that enter the rivers of Great Britain five times greater than the number that come to our streams in Canada?

THE SALMON FISHING SEASON OF 1928

THE SALMON FISHING SEASON OF 1928

WHY was the salmon fishing so poor in 1928? Why did so few fish come to the rivers of Canada?

The anglers have different opinions on the subject. Some say the shoals of fish have gone to Newfoundland by mistake; this cannot be so, for although single salmon sometimes wander, the shoals do not. The theory that there has been a great disaster at sea is not probable, because although the shoals of salmon from the different rivers may pass the winters at the same degree of longitude at sea, the latitude must differ, for it is many miles from the mouth of the St. Lawrence River to the Bay of Chaleurs.

There is a demand that the "white whales" be hunted and destroyed, for it is "owing to them that the salmon have dis-

appeared." The white whale is the Beluga[1] or white porpoise, that grows to over 1,000 pounds in weight and no doubt does great damage to the fish of certain rivers, but it is impossible that the supply of fish should fall in all the rivers the same year from that cause. The Belugas might assemble in numbers off the mouth of one river during a certain season, and create havoc, or perhaps the St. Lawrence might hold more white porpoises certain years than during others, but this year (1928) all the rivers of Canada were short of salmon.

Some wise men maintain that the lack of fish was caused by poor spawning conditions during 1922–23. A good spawning season is one of low-water conditions, for then the spawn is deposited in the bed of the river, but if the water happens to be high at that season, the salmon are apt to use the bars, shallows and sides of the river for that purpose. In the latter case, the redds are greatly

[1] There is also a Beluga Sturgeon — hence Beluga Caviare.

damaged when the ice goes out during the spring freshet. The tiny alevins must be destroyed in great numbers.

What was the spawning condition in 1922? We keep no records and no one can answer the question. One thing I know is that there was a goodly supply of salmon in the Cascapedia in the autumn of 1922, for the fishing had been fairly good.

During 1928, a very early and moderate run of old, large salmon, mostly over 30 pounds each, arrived in the Grand Cascapedia and went on up, leaving a few fish in the pools. No further run arrived. I saw only two fish bearing sea lice.

I took 27 salmon that averaged 25 pounds. Twenty-three of these fish averaged 28 pounds. The usual large run of *maiden six-year-olds,* 3–3, did not come at all.

Why did this happen?

In studying the question, the first thing I discovered was that 1928 is not the "worst season on record." *Nine* years ago — 1919 — was worse, and the season of

1911 — *eighteen* years ago — was equally bad.

On making this discovery, I remembered that Professor O. Pettersson has written that the *moon* and the *sun* have considerable influence on the waters of the earth, and that the tide generating force *varies* through a *nine year period.*

In other words, the currents along the coast move *off and on shore* in *cycles of nine years.* In this century, the nine year cycle at furthest off shore began in 1903. The cycles run to date:

1903 — 1911
1911 — 1919
1919 — 1928

In each of these cycles salmon fishing was at its worst in the years mentioned, namely in 1903, 1911, 1919 and 1928; *at the end of each nine year cycle.*

I discovered this by examining the scores of the rod catch of both the Grand Cascapedia and the Ristigouche Club.

The rod record, however, depends greatly on weather and water. More fish might be taken during a season of good water conditions, even though fewer fish were in the river, than during a season of poor water conditions. I find the reports from the nets agree with the rod scores. Their *poor* years agree, as also do their *good* seasons.

If what Professor Pettersson says is a fact — *" the nine year cycle "* — then it is possible to explain, not only the bad and the good years of salmon fishing in the rivers, but also the good and bad seasons of all schooling fish along our coast, which has always puzzled fishermen.

Bluefish and mackerel are plentiful some seasons, scarce during other years. They visit our shores in early fall to feast on Sperling. When that harvest is over they make off shore again.

Sperling, *Menedia notata,* are the small fish we now eat and call " whitebait."

The currents that are moved off and on

shore in cycles of nine years *carry the bait:* —

Squid, menhaden, sardines, anchovies, "sora," shrimp and numerous other school fishes, are at the mercy of the currents and float back and forth on the tides, for they have not the strength to stem them.

All schooling fish feed *en masse,* and must follow the *bait or starve.* As the said currents move off shore for four or more years, fewer and fewer bluefish and mackerel visit our coasts, but as the turn comes for them to move in shore again, the fish increase in numbers year by year, for *where the bait is* there you will find the schools of larger fish such as tuna, bluefish, mackerel and, further north, the herring as well.

As I find the *rod catch* as well as the *net catch* of salmon agrees with the nine year cycle, and that the *poorest* years of this century have been:

1903 — 1911 — 1919 — 1928

I presume that the shoals of salmon also

follow the bait, for they need much food and must feed also *en masse,* and where food is very plentiful.

I judge that those years when the currents are *far off* shore are the *poor* salmon fishing years on the Canadian rivers, with the *worst year* at the *end of each nine year cycle.*

I believe the salmon is more or less of a bottom feeder, for the adult fish has a square tail, and we know by the nets that shoals of salmon average only six miles a day by daylight. They do not travel at night in the sea. If they were surface feeders, we should long since have discovered where they pass the Winters and the Summers in the sea.

Anyone who has watched a school of bluefish feeding on menhaden knows what havoc they create. They destroy ten times the amount of food that they eat. Can it be possible that the shoals of salmon follow the surface feeding fish, below the surface and feast on the crumbs from the rich man's table?

As 1928 is the end of a nine year cycle,

only the heavy fish, that had been in our river at least once before, had the energy to return. The maiden 3–3's did not come; perhaps they were too far at sea for the fresh water from the rivers, which is their inspiration to return, to reach them, or else, a place where food is good and plentiful may be a more pleasant summer resort than a river when the journey is at its longest.

Those years, such as 1922, when the figures of the catch do not run quite true, can be explained perhaps by heavy easterly gales during the Winter of 1921–22, which shifted the currents closer in shore than they would be normally — the journey was not so long or the inspiration of the taste of the fresh water stronger, and more fish came than would have come under normal conditions.

If I am right, it will be easy to pick the four or five best seasons out of each decade in the future, that is, as to the number of fish to be expected. The actual fishing depends on weather, water, skill, and luck. It

also means that the salmon fishing will be poor in 1929–1930 and probably 1931. It should improve in 1933 and be good in 1934 and 1935.

	CASCAPEDIA CLUB	RISTIGOUCHE CLUB
	7 to 8 RODS	20 to 30 RODS
1911	141	969
1912	151	780
1913	162	1039
1914	149	1044
1915	186	1334
1916	337	1299
1917	390	1525
1918	336	1272
1919	209	589
1920	248	917
1921	206	1029
1922	413	1615
1923	434	1345
1924	589	1804
1925	567	1858
1926	543	1558
1927	480	1315
1928	190	711

THE ROYAL COMMISSION REPORT
of the Nets in Cwts.

	NEW BRUNSWICK	PROVINCE OF QUEBEC
1911	13,017	8,410
1912	13,877	9,091
1913	17,985	12,761
1914	17,056	11,699
1915	17,867	11,795
1916	17,791	15,302
1917	15,983	13,532
1918	17,452	11,139
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1920	11,477	4,927
1921	20,383	7,805
1922	16,859	12,205
1923	20,682	14,765
1924	33,563	15,080
1925	30,073	20,714
1926	25,151	15,536
1927	22,464	14,840
1928	12,166	6,905

A catch of 20,000 cwts. of salmon would mean 100,000 fish of 20 pounds each.

Pau
September 7th 1928

PROFESSOR OTTO PETTERSSON
Goteborg
Sweden

Dear Professor,

Would you have the great kindness to read the enclosed paper and let me know if there is anything in my theory? It all depends on your "nine year cycle of the tides" which interests me greatly. Our salmon run was very light in Eastern Canada this season (1928), and I am trying to find a good reason for it. I have your address from Professor Thompson who advised writing to you for information. Please pardon me for troubling you.

Yours Sincerely
F. GRAY GRISWOLD

15 Sept. 1928
Svenska Statens
Bevaknings och Undersökningsfartig
Skagerak

To Mr. F. Gray Griswold

Sir,

Being occupied with a hydrographic excursion in the Skagerak I have not got an opportunity to answer your letter of 7th Sept. before. The accompanying paper on the salmon fishing 1928 and the statistics from the beginning of this century I have read with great interest. I have hitherto only studied the periodicity of the herring fishery in the Northern Atlantic and was agreeably surprised to hear that the salmon is a fish that merits a study from the same point of view.

I herewith return the typewritten M.S. which I hope you will publish as soon as possible and send me a copy. I find the periodicity in itself a statistical fact worth to be noticed. Regarding your " working hypothe-

sis," or explanation, I must say that it agrees with my own ideas. In the last number of the Geographical Journal there is an important paper by the leader of the Discovery Expedition, Professor Hardy, who explains the rich "fishery" of whales at S. Georgia thus:

S. Georgia lies as a "breakwater" exposed to the current through the Drake Strait from the Pacific Ocean. This Antarctic Current carries immense quantities of diatoms. On the East side of S. Georgia it forms an eddy with relatively stagnant water. The copepods assemble there and are consumed by the fishes, whales, and so forth. This hydrographic situation makes S. Georgia the eminent whaling region that it is. We ascribe the migrations of fishes either to their want of food, or to their spawning instinct. If it here were question of migration in quest of food, I would ask if there had been any research made of the copepods in the Canadian waters, but as it is evidently the opportunity for spawning which attracts

the salmon shoals to the Canadian coast; "inspired," as you say by the fresh river water from the continent which can be more or less deflected by currents, there remains the possibility that the periodicity of salmon fishing may depend on periodicity in the current system of the ocean, and in the last instance on variations in the interaction between the Sun, Moon, and the Earth.

Yours truly
O. PETTERSSON

THE PACIFIC SALMON

THE PACIFIC SALMON

IT had been believed that all the salmon that were hatched in the rivers of the Pacific Coast went down to the sea before their scales were formed, and that they all returned when they were four years old to spawn.

When Professor Charles H. Gilbert made his scientific study of the scales of these fish he discovered much that was interesting.

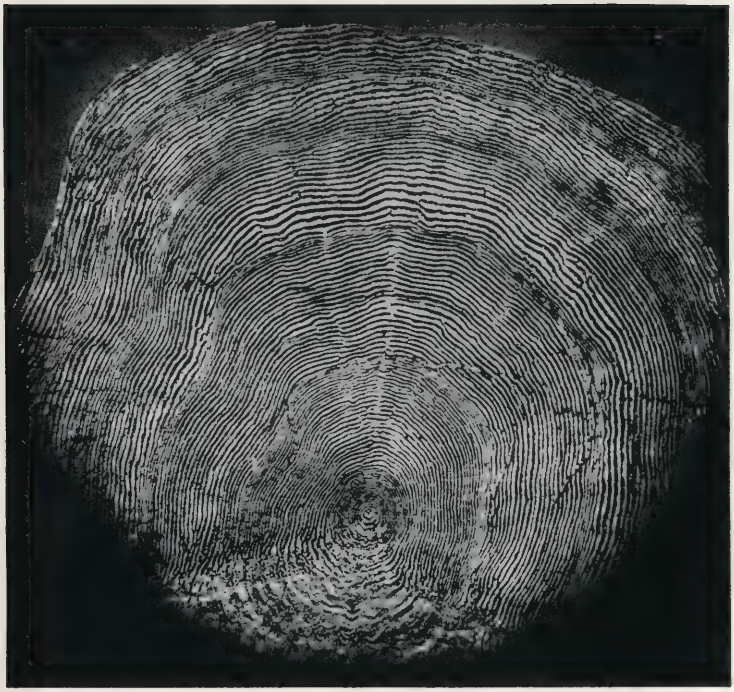
Although these scales are formed in the same manner as those of the Atlantic salmon, their appearance differs. They lack the strongly marked smolt centre and have no spawning marks. This is quite natural, for the fish do not remain several years in fresh water before going to sea and they only spawn once and all die after spawning.

This is of peculiar interest as concerns this species, for as they all die at maturity the question of their age is of great importance.

"The scales of the Pacific salmon persist throughout life and grow in porportion with the rest of the fish, principally by additions around their borders. At intervals there is produced, at the growing edge, a delicate ridge upon the surface of the scale, the successive ridges then formed being concentric and subcircular in contour, each representing the outline of the scale at a certain period in its development. Many of these ridges are formed in the course of a year's growth. Spring and summer being a period of rapid growth, the ridges are widely separated, while the winter ridges are close together. These two areas constitute a year's growth."

In the early spring two sizes of young sockeye or red salmon have been observed on their downward migration to the sea. The larger are yearlings, which instead of going to sea the previous spring as fry, have remained in the lake during their first year. The smaller are the fry just hatched.

This happens also with the tyee or chinook and also with the coho salmon. The hump-



PACIFIC TYEE SALMON
Sixth Year

back and dog-salmon always migrate to the sea while in the fingerling stage.

All species of Pacific salmon cease to feed on entering fresh water on maturity.

It has been found that while the majority of the Fraser River run are in their fourth year when they return to the river, a considerable number of them, including all the larger individuals, are in their fifth year. The smaller fish which return are three year old grilse.

The largest variety, the chinook, tyee, or king salmon, run to a great size, it is claimed to 100 pounds. I have seen a tyee that weighed 72 pounds, and have taken them over 60 pounds in weight. The fishermen always insisted that these fish were only four years old, which I could not quite believe. From the investigation of the scales it has been ascertained that there are male fish of this species six and even seven years old that return to spawn. The females are mostly in their fourth year, and the small, so-called spring fish or sachems, which accompany the

run, are grilse, precociously matured males that are two or three years old.

Professor Gilbert's summary on the subject is:

1. The sockeye spawns normally either in its fourth or fifth year, the king salmon in its fourth, fifth, sixth, or seventh year, the females of both species being preponderatingly four year fish.

2. The young of both sockeye and king salmon may migrate seaward shortly after hatching, or may reside in fresh water until their second spring. Those of the first type grow more rapidly than the second, but are subject to greater dangers and develop proportionately fewer adults.

3. Coho salmon spawn normally only in their third year, but adults are developed almost exclusively from those which migrate as yearlings.

4. Dog salmon mature normally either in their third, fourth or fifth years, the humpback always in their second year. The young of both species pass to the sea as soon as they are free swimming.

5. The term " grilse," as used for Pacific salmon, signifies conspicuously undersized fish which sparingly accompany the spawning run. They are precociously developed in advance of the normal spawning period of the species. So far as known the grilse of the king salmon, coho, and dog salmon are exclusively males, of the sockeye almost exclusively males, except on the Columbia River, where both sexes are about equally represented. The larger grilse meet or overlap in size the smaller of those individuals which mature one year later at the normal period.

6. Grilse of the sockeye are in their third year, of the coho and dog salmon in their second year.

7. The great difference in size among individuals of a species observed in the spawning run are closely correlated with age, the younger fish averaging constantly smaller than those one year older, though the curves of the two may overlap.